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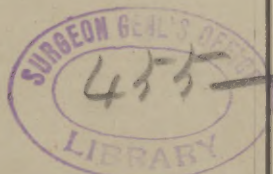
THE  
DOME-TROCAR;

ITS

*APPLICATION TO OVARIOTOMY, ASPIRATION,  
AND TRANSFUSION.*

BY

SIMON FITCH, M. D. (Edinburgh),  
NEW YORK.



[REPRINTED FROM THE NEW YORK MEDICAL JOURNAL, APRIL, 1875.]

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# THE POPULAR SCIENCE MONTHLY,

(Established May, 1872.)

Conducted by Prof. E. L. YOUMANS.

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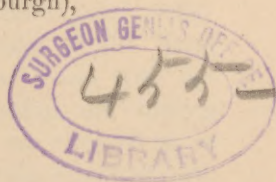
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## THE DOME-TROCAR; ITS APPLICATION TO OVIARTOMY, ASPIRATION, AND TRANS- FUSION.<sup>1</sup>

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THE trocar, formerly little valued, and seldom used, has recently attained a high rank in the surgeon's armature, and is now, even in its yet imperfect form, constantly employed in the detection, discrimination, and treatment of diseases which without its aid were occult or obscure, and intractable.

Many of these diseases, such as hydrothorax, and empyema, hydropericardium, hydatids and abscess of the liver, tympanites, strangulated hernia, retention of urine, with impermeable urethra, hydrocephalus, spina bifida, and various hurtful collections of fluids, cystic or free, are situated in, or adjacent to, either the lungs, or heart, or brain, or spinal cord, or abdominal viscera, or pelvic organs, or the great joints; and, when we consider how these sensitive and vital structures demand careful protection against all mechanical injury, beyond what is essential to the discovery and extirpation of their ailments, it will be evident that the instrument used in or upon such parts, whether for exploration or treatment, should be—

1. *Easy of insertion*, so that it may not bruise, lacerate, or stretch the walls of the cavity to be entered, nor disturb the connections or relationships of neighboring parts.

<sup>1</sup> Read before the Medical Society of the County of New York, February 9, 1875.

2. *Harmless when inserted*, so that it shall not injuriously abrade, nor scratch, nor puncture the interior of the cavity or adjacent structures.

3. *Competent to give the freest exit*, consistent with its size, to the fluids which are to be discharged.

4. *Apt to leave*, upon withdrawal, *such a wound as will most readily heal*.

The old trocar, with its canula fitting more or less loosely behind the triangular head, is a clumsy and dangerous instrument.

The aperture made by the point of the instrument is forcibly dilated by the bulging occiput of the trocar's head. Then the split end of the canula does not pass in smoothly, but as it is expanded, in being pushed forward over the head of the stylet, is liable to get entangled in the tissues at the edges of the triangular aperture, and so fail to enter perfectly, or, if forced in, past the obstruction, the orifice is still further stretched and the edges irritated, or perhaps lacerated; and, upon the withdrawal of the instrument, there is left a jagged, punctured wound, indisposed to heal by the first intention.

In 1850 Sir James Simpson had the head of the stylet reduced to the same size as the shaft, so that it should stretch the orifice less, and, as the canula could then be advanced without spreading, he omitted the split in the end, and Sir James at the same time announced his employment of a long, slender trocar, with an exhausting syringe attached, as a means of diagnosis in various internal enlargements, especially in pelvic tumors, and so initiated the idea which Dieulafoy subsequently elaborated into his admirable aspirator.

The idea of making the canula itself pointed, so as to penetrate independently of the stylet, was first suggested in 1853 by Fergusson, of London, who contrived a pen-like, tubular needle, for injection of perchloride of iron in the treatment of *nævi* and aneurisms.

In 1858 Dr. Alexander Wood, of Edinburgh, adapted this instrument to the subcutaneous injection of morphia, and a modification of the same instrument is now in universal use.

Spencer Wells shortly afterward enlarged this little tubular trocar for ovarian tapping, and made the edges of the



pointed end sharp and cutting for one-half the circumference of the tube, whereby a semilunar cut is made (if sharpened all round it would cut out a circular piece and leave a round hole), and he added a sliding outer canula, which, upon puncture being effected by the cutting point of the inner tube, is pushed forward as a guard against further action of that point.

This instrument, superior in many respects to the old trocar and canula, especially in respect of the wound made by it, being incised rather than punctured, has still in common with it this grave fault, that the protecting tube is on the *outside*, and if made thin, so as to pass more easily into the aperture made by the point of the inner tube, the open end becomes a cutting edge, dangerous to the interior of the cavity, and to the contained or adjacent viscera, as the bladder, when the contents are discharged by puncture, or the heart in tapping of the pericardium, or the lung in paracentesis thoracis, or the intestine in tapping for ascites. (The outer tube is sometimes obtusely pointed so that it may enter more easily, but this makes it more dangerous to the interior.)

But, if the terminal edge of the outer tube be blunted or made thicker, so as to better protect the interior, then it necessarily presents a resisting margin or shoulder outside and behind the point of the inner tube, liable to catch and carry before it the sac, or the immediate investment of the cavity, and so fail to properly enter.

Now, this accident may occasion considerable inconvenience, or even be productive of great harm, in cases of merely simple tapping, as, for instance, in hydrocele, where, if the tunica vaginalis is not very tense, it is oftentimes extremely difficult to get the outer canula pushed in over the puncturing end; and, in emphysema with a thick and tough pleura, so much force is sometimes required to urge the entrance of the outer tube as to really endanger a separation of the membrane from the ribs. And in tapping for the temporary relief of ovarian dropsy, if the outer tube do not follow the trocar quite into the cyst, or if, in entering, it catch and tear or split up a fragile cyst, more or less of the cystic fluid will escape into the abdominal cavity and is one cause of the fatality which sometimes follows this simple operation.

But should *injection* be attempted with an imperfect introduction of the protecting tube, whether that tube be the canula of the old trocar, or the outer tube of Wells's trocar, the result may be most disastrous.

I have seen intense peritonitis occasioned by tincture of iodine thrown upon the peritonæum in such an attempt to inject an ovarian cyst.

And Syme, in his "Principles of Surgery," noticing a like faulty injection for cure of hydrocele, remarks: "If the liquid is allowed to remain in the cellular substance, it gives rise to violent inflammation, and soon terminates in sloughing of the scrotum."

I encountered on many occasions difficulties similar to the above, and in common with others tried to obviate the uncertainty of entrance of the outer canula by cutting down to the peritonæum, or pleura, or tunica vaginalis, or whatever might be the immediate investment of the fluid to be evacuated or the cavity to be entered, until it occurred to me to reverse the relation of the tubes to each other, and while in Edinburgh, in 1871, I had an instrument made by Gardner upon the following plan: The outer tube, smooth and of uniform size, has the distal end pointed and cutting, like a lancet, so that it penetrates easily and to any depth, without the necessity for previous incisions of superimposed tissues, and the protecting tube being *inside* may then be advanced into the interior of the cavity, with absolute certainty of entrance, and without the possibility of even touching the margin of the aperture, or any of the tissues through which the outer tube has passed. The cutting edges of the puncturing-tube should rise from the point, not suddenly, nor in a curvilinear form, but gradually, and in a perfectly straight line, making an angle of less than 45° with the pointed side of the tube, so that it shall enter by a clean incision, and without stretching the aperture.

Instruments similar to the above were made for me by Krohne & Sesemann, in May of that same year, and were exhibited at the next meeting of the British Medical Association in London, August, 1873. The largest size is noticed in Spencer Wells's recent work on "Diseases of the Ovaries," p. 336. But the smaller-sized instruments seem to have been



overlooked, for Mr. Alfred Goodrich, in a letter to the *British Medical Journal*, August 8, 1874, says: "In emptying a cavity with the aspirator, the operator is often alarmed by finding the instrument filled with blood, arising from the walls of the collapsing cavity being forcibly sucked against the sharp point of the needle;" and he proposes, as if it were his own idea, that the trocar consist of two tubes, the outer one pointed, the inner one not so.

But in the *Journal* for August 22d, Mr. George Brown, of the Northeastern Hospital for Children, referring to Mr. Goodrich's suggestion of a trocar guarded by an inner tube, remarks: "The idea is not original; we have had one in constant use for more than twelve months, which was supplied by Messrs. Krohne & Sesemann," who were the makers of my instrument in 1871, and which in the catalogue of the museum at the forty-first annual meeting of the British Medical Association is designated "Wells's Trocar, improved by Fitch."

Yet *this* instrument is *not perfect*, for, although the certain entrance of the protecting tube is securely provided for, against possibility of failure, yet the open end of this same tube may itself be a source of danger, especially in the aspirator trocar, when it must be made very thin to avoid bulk.

In the August number of the *Journal* just quoted, a correspondence appears in reference to a successful paracentesis for hydrops pericardii, where Mr. Singleton Smith, upon whose patient the operation was performed, admits the risk which accrues from not only the point of a trocar allowed to remain within the cavity of the pericardium as the fluid drains off, but also from the sharp edge of the canula rubbing against the pericardium, or coming into contact with the beating heart.

And about the same date, the *Lancet*, under the head of "Medical Facts," observes that in "tapping of the chest when the fluid has been evacuated by the exhausting apparatus, the lung in expanding may strike against the sharp and hard canula. To prevent this, M. Béhier, of Paris, uses a canula of soft metal to be introduced into the ordinary tube, which, when the pleura is emptied, bends down against the parietes of the chest, and the lung does not suffer."

Now, a tube of soft metal cannot be safely drawn very

thin, and, were it made large enough for the bore to be permeable to fluids, it would be too bulky to enter a small canula.

Again, were it used with a tubular trocar, it would, upon bending down, leave the *point* of the trocar exposed. Or, if used in conjunction with the old trocar and canula, the stylet would have to be removed before the soft tube could be inserted, and then it would interfere with the adjustment of the aspirator, unless pushed in beyond the attachment of the aspirator, when, if it became bent down against the parietes of the chest, it would be in danger of slipping into the cavity upon the withdrawal of the canula. But an insuperable objection to this contrivance is, that the impingement of the lung against the soft-metal tube upon any sudden movement of the patient, or from the coughing which generally occurs during the evacuation of the chest, and the consequent expansion of the lung, would bend down the tube prematurely, and stop the flow of the fluid.

I have now to announce a *most important* modification of the double tubular trocar, which covers the danger of the open canula, and by which the instrument, while performing its ordinary functions safely and efficiently, shall be a trustworthy exploring probe or sound; and by which I believe many lives will be saved.

I have had the distal orifice of the inner canula closed over by a rounded or dome-shaped roof, so that, when *it* is projected beyond the cutting-point of the outer canula, the two tubes fit closely together, and the end of the combined instrument feels perfectly smooth like the end of a sound or catheter, and may be freely moved within the cavity penetrated, as the ovarian cyst, the abdomen, the thorax, the bladder, or even the pericardium, without danger of wounding any viscus or organ, puncturing any vessel, or even scratching or abrading the lining of the cavity, or of any parts contained therein. The base of this dome being of the same external circumference as the inner tube, and fitting the outer tube accurately, when the point of the instrument enters a cavity there can be no escape of fluid, till the dome is advanced, occluding the cutting-point of the outer tube; then there is disclosed a fenestra or oval aperture on *the under side* of the inner tube, cut out of the



lower wall and one-third of each side-wall, of the full size of the bore of the tube, and by which the fluid may be freely evacuated. The segment in the tube forming the distal end of the fenestra is sloped off toward the dome, so that a flake of plasma or accidental piece of tissue resting upon it will easily slip off upon the instrument being moved. But the lip at the proximal boundary of the segment projects, in a curve, over nearly a third of the fenestra, so that the fenestra may not be obstructed by any substance in the cavity.

The trocar thus constructed is harmless to the parts requiring protection, and the fenestra, so guarded and being moreover on the under side, cannot be stopped by the wall of the cavity coming into contact with it, as often happens to the open end of the old canula, nor by the falling upon it of the viscera or any layer of false membrane; and, if there be an aggregation of cysts or a multilocular sac, the instrument may be employed as a probe or sound, or a long artificial finger, with which to feel for a proper place, where it may be held till the cutting-point is advanced to make an aperture for its introduction.

Thus, in ovariectomy it will be found extremely convenient, the left hand supporting the tumor and the right holding the instrument, which can be instantly changed, by an easy movement of the same hand, from a trocar to a sound and *vice versa*, to define and puncture cyst after cyst, until the bulk of the whole is sufficiently reduced to admit of withdrawal through the abdominal incision, and with only one outer aperture in the sac first punctured, and this always occupied by the instrument; and the dome-trocar may be here used, where the end of the open tube could not be safely, to stir up and liquefy loculose contents, and to break down such obstructions to the flow as imperfect septa and membranous intersections, while it still plugs the original aperture, preventing the escape of cystic fluid into the cavity of the abdomen, and may oftentimes obviate the necessity of enlarging the aperture in the cyst for the introduction of the hand.

And, in operating against hydatids, as, for example, of the liver, the dome-trocar of small size may be used to dis sever and disintegrate the hydatids, while the aspirator is extracting



them through the same instrument. Or it may be employed to search for and drain off the last drops of urine during aspirato-puncture of the bladder, which we dare not do with the end of the open canula.

In the ovarian trocar, and in the trocar for paracentesis abdominis, the inner tube is advanced or retracted, and fixed in either position, by means of a thumb-rest. A curved metallic tube, fitting upon the proximal end of the outer canula, serves as a handle, and directs the current downward, and one end of an India-rubber tube three feet long may be drawn over the lower orifice of this curved hollow handle to conduct the liquid into a receiving-vessel. The middle of this tube is expanded into a bulb by which the flow through the tube may be promoted or hastened, and the cavity more rapidly and perfectly exhausted, or washed out or injected. The handle is fastened by a screw on the right side, and can be removed, and the tubes separated for cleansing. For the original idea of the thumb-rest and the handle, I am happy to thank Dr. Thomas Keith.

The wooden ring with Wells's grapples may be slipped upon the instrument. Or light, long clamp forceps may be used, with numerous teeth in the broad distal ends, by which the sac may be easily seized immediately upon or even before puncturing, and, being held in the hand with the trocar, accommodate themselves readily to the varying distances to which the trocar enters; or they may be attached to the instrument by a sliding ring, narrower than Wells's, or by a shifting ratchet.

The smaller sizes have no handles, for, owing to their fineness, they will enter with very little force, and it is generally desirable to attach the aspirator either before or immediately after puncturing.

The *attachment* is instantly effected by pushing the conical end of the aspirator-nozzle into the proximal end of the inner tube, and fixing it by one turn of a ring-nut, like a hose coupling, which makes the joint perfectly air-tight, and without moving either the trocar or the aspirator.

When an India-rubber tube is used between the nozzle and the aspirator, a bit of glass-tubing, with a flange on each end,

is fitted into it near its attachment to the nozzle, and similarly into the India-rubber tube of each of the larger-sized trocars, so that the current may be observed, or its absence noticed.

A hole or window may be made in the middle of the outer canula, with a similar hole in the inner tube, so situated that, if the inner tube be advanced, say, half an inch for the smaller and an inch for the large sizes, beyond its ordinary full projection, then the two openings shall correspond, and a silver probe or whalebone stylet may be introduced from these corresponding apertures to or through either end of the trocar without removing it from the cavity, and without detaching the connection with the syringe or aspirator.

To favor this clearing of the distal portion of the trocar, the dome is made solid, with the base slanting in such way as to throw out of the fenestra any probe, or wire, or stylet, inserted from below, and, with it, any obstruction of this orifice.

There is a very important operation which I think may be performed by the aid of the dome-trocar with great ease and safety. I refer to *transfusion*. A trocar of suitable size having been attached to each end of an India-rubber tube a foot long, with the middle expanded into a bulb, one of the trocars is inserted into the vein which is to furnish the blood, and, when the apparatus is filled, the other trocar is introduced into the receiving-vein, and the operation is completed.

The receiving-vein should be exposed by a short incision, but the supplying-vein will generally be sufficiently prominent to be entered without previous dissection.

In the ordinary mode, after cutting down to the vein, an incision or puncture is made into it, preparatory to the introduction of the tube. Now, it is difficult to get the end of the tube commonly used into the puncture, if only of the exact size to admit it; and, if the puncture be larger, a ligature upon the vein around the tube is afterward almost indispensable, to prevent leakage and waste on one hand, and admission of air on the other. But, with the dome-trocar, no previous opening of the vein is required, the puncture being made with the lancet-like point of the instrument itself. The tubes pass in instantly and with absolute certainty, and so accurately fill the incised punc-

ture that there can neither be escape of blood from the vein, nor entrance of air into the vein from the outside of the tube; and, as, after the apparatus is filled, the tubes are closed by the domes up to their very ends, neither can there be any entrance of air through the tubes. As soon as the lancet-end of the outer tube is inserted, the dome is projected from the interior, and the tubes, thus guarded, may be safely pushed as far as required, downward into the furnishing-vein, and upward into the receiving-vein, and no ligature will be needed. Thus time, so valuable in this operation, is saved, disturbance of the vein is avoided, and injury to the interior of the vein need not be feared. The anastomosis between the veins being thus established, the flow from the supplying to the receiving vein will probably go on spontaneously, or may be favored by gentle manipulation of the elastic bulb. The tubes are closed and opened, at their distal ends, by retraction and projection of the domes; no other valve or stop-cock is needed in the apparatus.

If the mediate method is preferred, a common glass or metal cylinder-syringe, with the piston removed, and the nozzle inserted into a flexible tube, armed with the trocar closed, will be a suitable reservoir, into which the blood may be caught as in ordinary venesection; or the blood may be defibrinated by whipping, and strained into the syringe; then inserting the trocar, we need not replace the piston, for sufficient and more steady propulsion may be obtained by merely raising the syringe. It would be wrong to force into the vein any clot which might obstruct the instrument. Mr. Wagstaffe uses a nozzle, with the hole half an inch from the extreme point, which he introduces through a puncture, and ties into the vein; this nozzle may be withdrawn sufficiently to expose the hole for the removal of obstructions, while the closed end still remains within the vein; and the expedient might be applied to this instrument by merely placing the fenestra farther from the distal end. But so little time is required for the operation with the dome-trocar that a clot, which is the only obstruction to be anticipated, need never occur. Should the plan, however, be adopted, the end of the canula beyond the fenestra should be solid, to prevent clotting from lodgment of blood there; and the trocar, so modi-



fied, should be reserved for this one operation, as the long projection of the end beyond the fenestra would be a disadvantage in all other cases for which the instrument is required.

The hole in one side of the nozzle, as used by Mr. Wagstaffe, would be in danger of occlusion from the contiguous wall of the vein; in the dome-trocar this is provided against by having the proximal end of the fenestra protected by a curved projection of the tube-wall, open at the sides, as previously described.

I believe the dome mounted upon a long steel spring, instead of an inner tube, may be used within a catheter-shaped puncturing canula for tunneling the insurmountably enlarged prostate, and perhaps applied to internal urethrotomy and laryngotomy.

The instruments may be of any size. Of those which I have had made, the largest is the *ovarian trocar*, which has a total length of twelve inches, the handle being four inches, and the inner canula, besides the portion within the handle, eight inches, with an internal diameter of half an inch. Dr. Washington L. Atlee used this in his last ovariectomy, and expresses unqualified approval of it.

That for *paracentesis abdominis* is exactly half the size of the ovarian trocar.

These larger sizes are of German silver, with the cutting portion of steel. The smallest sizes correspond in calibre with Dieulafoy's aspirator-needles, but are longer, being five and one-half to eight inches in length, for exploratory sounding, for emptying deep cavities, and for other purposes previously named. They are *aspirator-needles*, the contact of which will not harm, more than a smooth probe, the brain, the spinal cord, the lungs, the heart, the intestines, the bladder, the joints. These aspirator sizes have both canulas made of very thin steel. I owe much to the enthusiasm and dexterity of the Messrs. Tiemann, who have accurately and beautifully made all these instruments.

Perhaps I overrate the value of the *dome-trocar*, but I do hope the instrument is nearly what I assumed the perfect trocar should be: *easy of insertion; harmless when inserted; competent for the free passage of fluids; leaving a wound ready to heal.*

Figs. 1, 2, 3, represent the ovarian trocar; 4, 5, the aspirator needles.

The intermediate sizes for paracentesis abdominis, hydrocele, paracentesis thoracis, and transfusion, are sufficiently expressed by one or all of these figures.

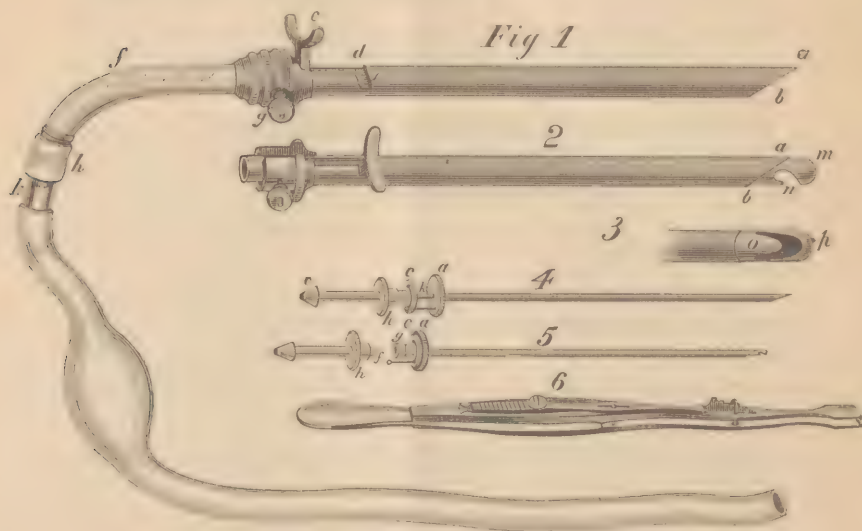


Fig. 1 has the dome retracted, disclosing the point and straight cutting edge (*a b*) of the outer canula, and excluding the instrument behind the point, against ingress or egress of fluids.

The thumb-rest (*c*) attached to the inner canula may be pushed forward in the slot (*d*) and turned into the branch-slot (*e*), advancing the dome and bringing the fenestra to the under side (as in Fig. 2).

The tubular handle (*f*) has the larger end fastened upon the outer canula by the screw (*g*).

A recess in this end of the handle holds an India-rubber washer, which, fitting closely around the inner or dome canula, makes the continuity of the long India-rubber tube with the interior of the instrument virtually air-tight, and sufficient for all requirements in ovariectomy or in abdominal tapping.

But, should absolute imperviousness be desired for perfect exhaustion, or for injection of a cavity, the *handle* may be

reversed, the smaller end (*h*) screwed upon the proximal end of the *inner* canula, and the orifice of the India-rubber tube drawn over the larger end of the handle.

Or the *aspirator* may be attached to the inner tube, either directly or with the intervention of the handle. The instrument, as at first made, had the handle continuous with the inner canula, and the thumb-rest upon the *outer* tube; but it is not so easily worked with one hand as in the present arrangement.

The India-rubber tube is shown in this figure with a bit of glass tube (*k*), by which the presence and character of the fluid may be observed, or its absence noticed.

The bulb is a *simple expansion of the tube*, so as not to interrupt the easy flow of fluid, or to whip the blood in transfusion, as might occur were the bulb connected by any sort of joint with the tubes, between which it is placed.

This bulbous tube may be used for the ordinary emptying or washing out of cavities, or for aiding the current from vein to vein in direct transfusion, or for quickening the flow from the elevated reservoir in mediate transfusion if it seem sluggish.

Fig. 2 shows the proximal end of the inner canula, projecting, to which the smaller end of the handle may be screwed, or the aspirator attached.

In this figure the thumb-rest is pushed forward, and turned into the branch-slot, projecting the dome (*m*) which sheathes the point and cutting edge (*a b*) of the outer canula, and disclosing the fenestra cut out of the under and side walls of the inner canula.

(*n*) in Fig. 2, and (*o*) in Fig. 3, show the curved process of the lower wall of the inner canula underlying the proximal third of the fenestra to prevent occlusion from contact of the sac or the vein-wall, or any other substance.

Fig. 4 is the aspirator needle with the dome retracted, and the nozzle attached.

Fig. 5, the dome projected and the nozzle detached.

(*a*) is a circular plate or disk, by which the outer canula is advanced, or retracted upon the inner canula and dome, dispensing with the slot incident to the attachment of the thumb-rest to the inner tube.



(*k*), a rod, playing in the slot (*o*), by turning which the tubes may be taken apart for cleansing

(*e h*) the nozzle corresponding to the tubular handle of the larger sizes (*e*), the proximal end over which the India-rubber bulbous tube, or the tube of the aspirator, may be drawn.

(*f*), the distal end, *conical*, to be inserted into the *funnel-shaped* end (*g*), of the inner canula, and tightened and fixed by the hose-coupling nut (*h*).

Fig. 6 the *clamp forceps*, to be made light and slender.

Where the trocar is used for injection, the end of the inner tube, instead of having one fenestra, might be perforated with numerous small holes, so that the injection should issue from them in the form of spray.

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